

1946

Geological Notes on the Northern Natural Gas Company Well Near Oakland, Iowa

Stanley E. Harris Jr.
Iowa Geological Survey

Copyright © Copyright 1946 by the Iowa Academy of Science, Inc.
Follow this and additional works at: <https://scholarworks.uni.edu/pias>

Recommended Citation

Harris, Stanley E. Jr. (1946) "Geological Notes on the Northern Natural Gas Company Well Near Oakland, Iowa," *Proceedings of the Iowa Academy of Science*: Vol. 53: No. 1 , Article 28.
Available at: <https://scholarworks.uni.edu/pias/vol53/iss1/28>

This Research is brought to you for free and open access by UNI ScholarWorks. It has been accepted for inclusion in Proceedings of the Iowa Academy of Science by an authorized editor of UNI ScholarWorks. For more information, please contact scholarworks@uni.edu.

GEOLOGICAL NOTES ON THE NORTHERN NATURAL GAS COMPANY WELL NEAR OAKLAND, IOWA¹

STANLEY E. HARRIS, JR.

PREVIOUS WORK AND ACKNOWLEDGEMENTS

The study for this paper is based on the work of the many geologists who have studied and correlated the stratigraphy of Iowa. The writer is particularly indebted to the subsurface geologists who have traced the geological formations from the surface outcrop areas into the subsurface by means of examination of well cuttings. The foundation for this work was laid by W. H. Norton who continued to be the principal contributor for many years. In 1934, under the direction of A. C. Tester, then Assistant State Geologist, the emphasis on subsurface studies was greatly increased. This effort has been continued under H. Garland Hershey, now Associate State Geologist, with the result that the cooperation of the drillers throughout the State has improved continuously. Under the direction of these two men great strides have been made toward a better understanding of the subsurface geology of the state. Several subsurface geologists have made significant contributions in the last few years, including F. B. Conselman and R. A. Carmody, petroleum geologists, and W. C. Schuldt, M. M. Elias and J. B. Carrier, of the Iowa Geological Survey.

The interpretations of the writer are based on the work of his predecessors and of his colleagues on the present staff of the Survey. Thanks are due especially to A. G. Unklesbay and Allen F. Agnew for valuable discussions during the second examination of the well cuttings by the writer, and also during the preparation of the manuscript. Drs. A. C. Trowbridge and H. Garland Hershey have reviewed the manuscript, and their suggestions for its improvement have been gratefully included in the final draft.

DISCUSSION OF GEOLOGIC SECTION

The Northern Natural Gas Co. water well 4 miles east of Oakland, Pottawattamie County, Iowa, was drilled to a depth of 3183 feet. It is in the southwestern portion of the State where deep wells are few and far between. Hence any deep well record is valuable and one such as this, from a well drilled with cable tools and sampled regularly at five-foot intervals by competent drillers, is noteworthy.

It is the purpose of this paper not only to give particular notice to this well record but to indicate that the formational units which outcrop in eastern Iowa can be carried across the State in subsurface with considerable assurance. Although much is still to be learned and many difficult problems confront the subsurface geologist, considerable progress has been made. Excellent sets of samples taken

¹ Published by permission of the Director, Iowa Geological Survey.

at 5-foot intervals, such as that saved from the Northern Natural Gas Company well, will do much to advance our knowledge of the sub-surface stratigraphy of Iowa.

The writer has examined the samples from this well twice, once while the well was being drilled and again about a year later. Examination was done by means of a binocular microscope generally with 9 power magnification but 18 and 36 power were used when needed. Sample descriptions were made on a strip log by means of the color symbols used by the Iowa Geological Survey and supplemented with verbal description where necessary. The generalized geologic log of the well at the end of the text is based on the strip log.

Bedrock, entered at 215 feet beneath glacial drift, is probably the Vilas shale in the lower part of the Lansing group, Missouri series of the Pennsylvanian system. The underlying Kansas City group correlates satisfactorily with other wells in the area. Certain units, such as the Hertha at the base, the Hushpuckney shale, Bethany Falls limestone and others are readily identified by lithology and stratigraphic relationships.

The Des Moines series is 807 feet thick here and compares favorably in this regard to other wells of southwestern Iowa. This thickness is, however, considerably greater than in the outcrop area to the east. Wells in Dallas and Warren Counties show about 500 feet. The difference is almost entirely within the Cherokee group.

The Henrietta group of the Des Moines series is well represented and can be correlated confidently with well sections eastward to Warren County, which is in the outcrop area. The 50-foot thick red shale above the Worland limestone in the upper part of the group, the Mystic coal and Fort Scott limestones at the base are important markers. These units are readily identified in this well as is also the Mulky coal at the top of the underlying Cherokee group.

The Ardmore limestone (Cherokee group) is an important stratigraphic unit in south central Iowa and appears to be represented by the limestone from 735 to 745 feet. For about 250 feet beneath the Ardmore the section is composed mostly of shales and these are followed by about 200 feet of slightly micaceous, medium-grained sandstone. Siderite is abundant in the form of spherical pellets and hard, brown fragments which commonly break with a subconchoidal fracture. These sandstones are apparently the equivalent of the oil producing beds in the Tarkio field, some 65 miles to the south. The base of the Cherokee group and of the Pennsylvanian system is marked by 65 feet of black and brown shales.

In general the subsurface correlations in the Pennsylvanian system must be made by identification of sequences of units rather than by the individual units themselves. The most valuable criteria for the recognition of the various sequences are black shales, red and green shales, chert, and the fossil content of the limestones.

The Mississippian rocks occur between 1265 and 1800 feet in depth. The youngest formation is the Ste. Genevieve, the uppermost 77 feet is variegated shale similar to that exposed in the Ft. Dodge area.

The base of the formation is a sandy, oolitic limestone much thinner than its equivalent in the Iowa type locality at Pella, southeast of Des Moines. The dense, fine-grained to sublithographic limestones (some of which are sandy) beneath the Ste. Genevieve are placed in St. Louis formation.

The Warsaw formation, though represented by only 25 feet, is typical of that unit as identified in subsurface occurrence by the Iowa Geological Survey. It is composed of greenish gray shales and brown, fine-grained, granular, argillaceous dolomite. The accompanying chert is stony and subwhite to dark gray in color. "Watery" and orange or pink chalcedonic chert is also present; the latter is a striking lithology and is considered to be one of the characteristics of the Warsaw, although it may also be found occasionally in the underlying Keokuk formation.

Cherty carbonates of the Keokuk and Burlington formations make up the Osage group. The Keokuk is 80 feet thick and is composed mostly of cherty dolomite. The dolomite is predominantly brown, this color being due to brown argillaceous material, some in the form of partings. In the upper 50 feet there is a dark brown chert with white specks and spots. It is thought that some of the white spots may be crinoid pinnules because of their shape and because of the abundance of crinoid remains in the formation. This peculiar brown and white chert has been traced in subsurface across the State from southeastern Iowa. Neither the Keokuk nor the Burlington is very fossiliferous, probably because they are mainly dolomites in this region. The top of the Burlington is not so sharply marked as in southeastern Iowa. However, the cream, fine- to medium-grained limestone accompanied by white chert with light buff markings is quite distinct from the overlying grey Keokuk limestone. The lower part of the Burlington is dolomite.

The Kinderhook section has not been worked out satisfactorily. Much careful study is yet to be done in the area between north central and southwestern Iowa. The oolitic limestone between 1580 and 1630 feet is probably Gilmore City, and the chert and dolomite beds below are undoubtedly Hampton. It is interesting to note that some of this chert is a distinctive ash gray, apparently the same as that which occurs in the same stratigraphic position in the subsurface of parts of southeastern Iowa. This chert is associated with a light gray fossiliferous limestone believed to be the Chouteau of Missouri. Underlying the cherty dolomites in the Northern Natural Gas Company well there is a fragmental and oolitic fossiliferous limestone probably correlating with Chapin and North Hill limestones, which are called Chouteau by Laudon.

The following 145 feet between 1732 and 1877 feet is mostly shale, with some interbedded limestones and dolomites. This interval is believed to contain the Mississippian-Devonian contact, placed by the writer at 1800 feet where there is a change from light green shale with thin limestone beds to a darker shale containing dolomite beds. The Mississippian shales from 1732 to 1800 feet are tentatively

placed in the Maple Mill formation. This formation is something of a "catch all" which undoubtedly will eventually be broken down into more meaningful units. The shale below 1800 feet is believed to be Devonian in age but cannot be correlated satisfactorily at this time with any formations in eastern Iowa.

The "Hunton lime," in the oil men's terminology, at 1877 feet, marks the top of a long section of dominantly dolomite rocks. The dolomite is commonly accompanied by chert, but only a few shale and sandstone breaks are present from this point to the bottom of the well. The "Hunton" is the oil producing horizon in the Falls City, Nebraska, field. The base of the Devonian system of rocks is at 2270 feet. Although no formation names are applied to the carbonate part of the Devonian section, it is divisible into four units. The top unit, from 1877 to 1972 feet, is calcitic dolomite marked at the base by embedded sand grains. The second unit is cherty dolomite. In the top 20 feet subwhite and light gray chert with dark specks and a rough surface make up 20 per cent of each sample. The same type of chert and cottony tripolitic chert is present downward through the unit in smaller percentages. Sand also marks the base of this unit. Unit 3 is composed of buff dolomite and grayish green shale. The shale is distinctive enough to be spoken of informally as "the Devonian-type shale." It has a waxy luster and uniformly fine-grained smooth texture. Generally it is not dolomitic. The fourth and basal unit is dolomite and is cherty in the lower 50 feet in amounts up to 30 per cent. Chalcedony and authigenic quartz are also present. At the base of the Devonian system there is a concentration of St. Peter-type sand grains. This sandy zone is common over most of the State and in parts of southern Iowa and north central Missouri it is actually a sandstone several feet thick.

The greatest unconformity within the Paleozoic sequence in Iowa is at the base of the Devonian. At the site of the Northern Natural Gas Company well the Devonian rests on Silurian rocks which are only 45 feet thick, whereas in the Cedar Rapids area the Silurian section is about 300 feet thick. Southeastward from Oakland the Devonian rocks rest on successively older rocks. Not far from Oakland it overlies the Maquoketa formation but in north central Missouri it lies directly on Kimmswick or Galena dolomite.

The Silurian rocks in the Northern Natural Gas Company well are light gray dolomite accompanied by chalcedonic chert. The lithology is not particularly distinctive.

The Maquoketa formation is composed principally of chert and dolomite. Unlike the Maquoketa in much of the eastern part of the State, there is very little shale. The contact with the Silurian is marked by a concentration of tabular pyrite and grayish green, granular, dolomitic shale. The upper 50 and lower 23 feet are composed of dolomite with little chert, while the rest of the formation is dominantly chert with subordinate shale and dolomite beds. In some places the Maquoketa dolomite and chert contains black specks and spots, but this feature is poorly developed at this location.

The Galena formation is remarkably uniform over the entire State. Although absent from this particular well, the top 10 to 25 feet of the Galena formation is generally marked by cinnamon (colored) specks. These specks are present in all regions, though not in all wells, whether the Galena be limestone or dolomite. The Dubuque-Stewartville members are not readily separable in subsurface, and both are essentially free from chert. The top of the Prosser member is marked by white chert some of which is specked with brown dolomite rhombs. This upper chert zone is about 50 feet thick. Beneath it are two other cherty zones of lesser thickness containing smaller percentages of chert, largely tripolitic in character.

The Decorah-Platteville portion of the section in Iowa and Wisconsin is being studied in detail in subsurface by Mr. Allen Agnew of the U. S. Geological Survey. In this particular well the most noteworthy feature is the presence of dolomite beds within and at the base of the Glenwood shale member. The Glenwood shale retains its characteristics across the State, as it is here a splintery shale containing black phosphatic fragments and quartz sand grains.

Beneath the Glenwood shale the geologic section is normal to the bottom of the well. The St. Peter is composed of characteristically well-frosted and rounded, medium-grained quartz sand. The Prairie du Chien section is readily divisible into the Willow River and Oneota members. The interval from 2915 to 2940 feet might be referred to the Root Valley sandstone, but it is not especially well developed. The sandstone of this zone is angular and strongly secondarily enlarged as is normal for the Root Valley.

The Cambrian system is represented by the Jordan sandstone and St. Lawrence dolomite members of the Trempealeau formation. Both of these are normal in character. Drilling was stopped after 32 feet of the St. Lawrence had been penetrated, at a total depth of 3183 feet.

The geologic log of this well correlates closely with other logs in the region. It is a record which has added much to our knowledge of the subsurface stratigraphy of southwestern Iowa. The samples, on file at the Iowa Geological Survey in Iowa City, (W-1821) will continue to be valuable in studies of the various doubtful units of the stratigraphic column of Iowa and adjacent States.

CONSTRUCTION DATA AND GENERALIZED GEOLOGIC LOG

Name: Northern Natural Gas Company Well (1945).
 Location: NW corner sec. 11, T. 75 N., R. 39 W. Pottawattamie County, Iowa.
 Altitude at curb: 1294.5 feet.
 Total depth: 3183 feet.
 Owner: Northern Natural Gas Company.
 Contractor: Layne-Western Company, Omaha.
 Drillers: Howard Lacey, Donald Simpson and David Laird.
 Drilling dates: January 22, 1944, to June 1, 1945.

Casing record: 159'6" of 24" casing 0-159'6"
 231'9" of 20" casing 0-231'9"
 540'7" of 16" casing 0-540'7"
 1319'2" of 12" casing 0-1319'2"
 142' of 10" liner set from 1688-1830'
 1887' of 8" casing 0-1887' cemented top to bottom
 329'5" of 7" O.D. casing set from 1857'7" to 2187'
 96' of 5" I.D. liner set from 2719' to 2815'

Producing horizon: Jordan sandstone and St. Lawrence dolomite.
 Pump: Layne deep well turbine, 36 stage bronze bowl, 20' of 4" suction pipe, 480' setting to top of bowls with 5" discharge column.
 Production: 53 gallons per minute with 127 feet of drawdown from a static level of 335 feet.

Description of Formation	Thickness	Depth in Feet	
		From	To
Pleistocene system			
Post-Kansan			
1. No samples	50	0	50
2. Loess, chocolate brown, silt, leached, blocky	5	50	55
Kansan formation			
3. Till, buffish brown, oxidized; leached in top 5 feet	20	55	75
Nebraskan formation			
4. Till, light chocolate, leached	20	75	95
5. Till, light yellowish gray, oxidized but unleached; sand and gravel beds near base	60	95	155
6. Till, gray, unoxidized and unleached, little sand, few pebbles	60	155	215
Pennsylvanian system			
Missouri series			
Lansing group			
7. Shale, red and green, in part silty and calcareous	22	215	237
8. Limestone, slightly greenish gray, fine medium-grained. Chert, very light drab, semitranslucent	13	237	250
Kansas City group			
9. Shale, light gray and pale green	15	250	265
10. Limestone, cream, fine-grained, earthy, grading into marl, abundant <i>Triticites</i> . Chert as from 237 to 250 feet	11	265	276
11. Shale, medium to dark gray	12	276	288
12. Limestone 80%, crystalline. Shale 20% gray fissile, micaceous. Chert, brown, conchoidal, stony	12	288	300
13. Shale, red and green	5	300	305
14. Limestone, very light gray to drab,			

	<i>Description of Formation</i>	<i>Thickness</i>	<i>Depth in Feet</i>	
			<i>From</i>	<i>To</i>
	sublithographic to sugary, <i>Osagia</i>	12	305	317
15.	Shale, gray with some red and green, silty, fissile	3	317	350
16.	Limestone, light gray, fossiliferous, earthy hard	5	320	325
17.	Limestone 90%, light gray, very fine-grained to sublithographic, subconchoidal, fossiliferous, fusulinids present. Chert 7%, drab, semitranslucent.....	14	325	339
18.	Shale, black, fissile at top, gray to lavender below	16	339	355
19.	Limestone, cream to light gray, abundant fusulinids and other fossil fragments; alternating with gray shale.....	45	355	400
20.	Shale, medium to dark gray; shale black (Stark) fissile	10	400	410
21.	Limestone 95% (Bethany Falls) very light gray, fine-grained, dense. Shale 5%, brown	15	410	425
22.	Limestone 85%, as from 410 to 425 feet. Chert, drab, mottled, conchoidal, stony	13	425	438
23.	Shale, black, fissile	7	438	445
24.	Dolomite grading into limestone 95% (Hertha) sub-white, fine-grained, granular-crystalline. Chert 5%, light mottled, stony	13	445	458

Des Moines series

Henrietta group

25.	Shale, brown, laminated	9	458	467
26.	Limestone, light buff, sublithographic to fine medium-grained, crystalline	11	467	478
27.	Shale, red with some limestone interbedded	7	478	485
28.	Shale, green, gray, and red and brown in lower part. Sandstone 50% from 500 to 505, green micaceous	40	485	525
29.	Limestone (Worland) light gray to pale drab, mottled red in upper part.....	15	525	540
30.	Shale, medium to dark gray	5	540	545
31.	Sandstone, light green, very fine-grained, angular, micaceous, cemented by calcium carbonate	22	545	567
32.	Limestone, light buff, sublithographic to very fine-grained, fusulinids	3	567	570
33.	Shales 70%, red and gray. Limestone 30%	5	570	575
34.	Limestone 40%, cream gray, fine-grained, crystalline. Coal 35% (Mystic) Shale 25%, gray	10	575	585
35.	Limestone, cream gray, fine-grained.....	5	585	590
36.	Shale, greenish gray, blocky. Dolomite 40% from 610 to 620 feet, light medium gray with black specks	35	590	625
37.	Dolomite, light medium to dark gray, very fine-grained, dense	5	625	630

	<i>Description of Formation</i>	<i>Thickness</i>	<i>Depth in Feet</i>	
			<i>From</i>	<i>To</i>
38.	Limestone, yellowish cream, granular, dolomite rhombs embedded	5	630	635
39.	Shale, light drab, pink streaks	12	635	647
40.	Dolomite, yellowish cream, very fine-grained, granular. Limestone in lower part	12	647	659
41.	Coal 75% (Mulky). Shale 25%, medium gray	6	659	665
42.	Shale, gray and brown; alternating with siltstone, light gray, very argillaceous	73	665	738
43.	Limestone 60% (Ardmore), cream gray, dense, fossiliferous. Shale 40%, greenish gray	7	738	745
44.	Shale, dark gray to black	5	745	750
45.	Shale, gray and brown. Coal 10% from 780 to 785 feet	70	750	820
46.	Shale 70% brown fissile; sandstone 30% light gray with green specks, fine-grained, angular	25	820	845
47.	Shale, gray, variegated red, brown and green, micaceous, some silty	65	825	890
48.	Shale, light yellowish gray, laminated. Coal 10%	10	890	900
49.	Shale, gray, micaceous, laminated to blocky	100	900	1000
50.	Sandstone, light gray, fine- to medium-grained, angular, micaceous	50	1000	1050
51.	Sandstone, light yellowish gray, medium-grained, curvilinear to subangular, some polished. Siderite pellets and cement. Shale bands present	50	1050	1100
52.	Sandstone, fine medium-grained, more angular and less polished than above, slightly micaceous. Siderite pellets	50	1100	1150
53.	Sandstone, medium-grained. Siderite pellets abundant	50	1150	1200
54.	Shale, gray to black, fissile	45	1200	1245
55.	Shale, yellowish brown, blocky	20	1245	1265

Mississippian system

Meramec group

Ste. Genevieve formation

56.	Shale, red and green variegated, blocky. Limestone 5-15% from 1290 to 1308 feet, creamish gray, very fine-grained, crystalline. Slightly fossiliferous	52	1265	1317
57.	Limestone 70%, white, very fine-grained, crystalline, some oolitic, some argillaceous partings, sandy. Shale 20%, green. Sand 10%, fine-grained, angular to curvilinear	13	1317	1330

St. Louis formation

58.	Limestone, light gray and cream, very fine-grained to sublithographic. Crinoid stems	25	1330	1355
-----	--	----	------	------

1946]

WELL NEAR OAKLAND, IOWA

241

	<i>Description of Formation</i>	<i>Thickness</i>	<i>Depth in Feet</i>	
			<i>From</i>	<i>To</i>
59.	Dolomite 85%, very light buff, fine-grained, crystalline-granular. Shale 10%, green, calcareous. Loose sand 5%. Pyrite present	10	1355	1365
60.	Limestone, very light brown, sublithographic, conchoidal, slightly sandy. Dolomite 30%, very light brown, very fine-grained, glauconitic. Chert 5-10% white, conchoidal, opaque	20	1365	1385
61.	Limestone 40%, pale brown, fine- to medium-grained, very sandy, rounded chert grains. Dolomite 40%, buff, very fine-grained, saccharoidal. Sand 20%, medium-grained, curvilinear to subround, frosted	15	1385	1400
62.	Dolomite 40-60%, drabish brown, fine medium-grained, crystalline. Chert 20%, subwhite to dark gray, conchoidal grading into chalcedony; pink chalcedony present. Shale 20-40%, greenish gray, fissile, micaceous	25	1400	1425
Osage group				
Keokuk formation				
63.	Dolomite 40-50%, brown, fine-grained, cherty, argillaceous. Chert 40%, dark brown with white spots and watery, vitreous, translucent. Shale 10-20%, brown and green	25	1425	1450
64.	Dolomite 60%, brownish gray, very fine-grained, saccharoidal, highly cherty. Chert 40%, brown with white spots and pinnules; some banded.....	25	1450	1475
65.	Shale, bluish gray, dolomitic	5	1475	1480
66.	Limestone 60%, light creamish buff with gray specks, fragmental. dolomitic. Glauconite present	10	1480	1490
67.	Chert 50% and limestone 20%, as from 1480 to 1490 feet. Dolomite 30%, grayish brown, fine-grained, crystalline	13	1490	1503
Burlington formation				
68.	Limestone 60%, cream, fine-grained. Chert 40%, white, mottled buff with gray spots	7	1503	1510
69.	Shale 70%, green, calcareous. Limestone 20% and chert 10% as from 1503 to 1510 feet	5	1510	1515
70.	Limestone 60%, cream, fine-grained with dolomite phenoclasts. Chert 40%, light gray, mottled, semitranslucent. Glauconite present	20	1515	1535
71.	Dolomite 50%, light brown, fine-grained, argillaceous. Chert 30%, gray,			

	<i>Description of Formation</i>	<i>Thickness</i>	<i>Depth in Feet</i>	
			<i>From</i>	<i>To</i>
	conchoidal; quartzose chert 20%	20	1535	1555
72.	Chert grading into chalcedony 50%, white and subwhite, mostly translucent. Dolomite 35%, light gray, very fine-grained. Shale 15%, greenish gray	10	1555	1565
73.	Shale, light gray	5	1565	1570
74.	Chert 50%, light gray, mottled drab and gray. Dolomite 50%, molasses brown, saccharoidal	7	1570	1577
Kinderhook group				
Gilmore City formation				
75.	Limestone, cream, earthy, pseudo-oolitic, abundant ostracodes and crinoid fragments. Shale 30% from 1575 to 1580 and 80% from 1610-1615 feet, brown. Shales 10-25%, greenish gray, micaceous	53	1577	1630
Hampton formation				
76.	Chert 50%, light cream gray, granular, dolomitic. Dolomite 30%, drab buff, fine medium-grained. Limestone 20%, white, earthy, soft fossiliferous. Pyrite present	7	1630	1637
77.	Shale, light medium gray, some glauconitic	8	1637	1645
78.	Dolomite 40-60%, grayish brown, fine-grained, saccharoidal. Chert 20-40%, ash and pale brown, subconchoidal, opaque. Limestone 20%, from 1660 to 1690 feet, pale cream, fine-grained.....	45	1645	1690
79.	Shale 60%, green and brown. Limestone 40%, buff, fine medium-grained, crystalline	10	1690	1700
80.	Limestone 80-100%, very light brown with gray fossils, fine- to medium-grained, partly oolitic, fragmental. Shale 20%, 1700 to 1715 feet, green, micaceous, blocky	30	1700	1730
Maple Mill formation				
81.	Shale, light green, waxy, blocky to fissile. Limestone and dolomite beds present. Much pyrite 1730 to 1740 feet	70	1730	1800
Devonian system (undifferentiated)				
82.	Shale 75%, green and gray, some red present. Dolomite 40% from 1815 to 1830 feet, light grayish green, fine-grained, argillaceous. Limestone beds below 1835 feet, cream, fine medium-grained	77	1800	1877
83.	Limestone, cream, very fine- to medium-grained, crystalline with phenoclasts of dolomite	8	1877	1885

1946]

WELL NEAR OAKLAND, IOWA

243

	<i>Description of Formation</i>	<i>Thickness</i>	<i>Depth in Feet</i>	
			<i>From</i>	<i>To</i>
84.	Dolomite, buff, fine-grained, crystalline, dense, calcitic	50	1885	1935
85.	Dolomite, cream, very fine-grained, subconchoidal to fine medium-grained, crystalline	15	1935	1950
86.	Dolomite, cream, very fine- to fine medium-grained, calcitic grading downward into limestone, cream and gray, sandy. Shale 20%, pistachio green, splintery	23	1950	1973
87.	Dolomite 55%, light grayish drab, fine medium-grained. Chert 25%, subwhite and light gray, gray specked, rough. Shale 20%, drab	17	1973	1990
88.	Dolomite, cream buff, fine-grained, crystalline, semitranslucent. Calcite cleavage rhombs and tripolitic chert present	50	1990	2040
89.	Dolomite 75%, cream drab, very fine-grained, granular. Chert 15%, as from 1973 to 1990 feet. Shale 10%, light medium gray	40	2040	2080
90.	Dolomite, cream to light brown, very fine-grained, crystalline, dense; sandy, medium-grained, frosted, from 2100 to 2125 feet. Chert present, tripolitic.....	45	2080	2125
91.	Dolomite 80%, buffish brown, very fine- to fine medium-grained, crystalline, dense, brown argillaceous partings. Shale, grayish green, soapy, blocky. Shale, grayish brown, micaceous, fissile, black organic material.....	60	2125	2185
92.	Dolomite, cream, fine medium-grained	35	2185	2220
93.	Dolomite 90-80%, cream brown, very fine-grained, crystalline. Chert 10-20%, very light gray, conchoidal, opaque. Sand less than 1%, fine- to medium-grained, subround to subangular, very finely frosted (20% at base)	52	2220	2272

Silurian system (undifferentiated)

94.	Dolomite 75%, light gray, fine medium-grained, translucent, brilliant. Chalcedonic chert, white to watery, translucent, vitreous, some tripolitic.....	43	2272	2315
-----	--	----	------	------

Ordovician system

Cincinnatian series

Richmond group

Maquoketa formation

95.	Dolomite, cream gray, fine-grained, granular. Shale, apple green to grayish green, micaceous, fissile. Pyrite abundant	25	2315	2340
-----	--	----	------	------

	<i>Description of Formation</i>	<i>Thickness</i>	<i>Depth in Feet</i>	
			<i>From</i>	<i>To</i>
96.	Dolomite 90%, yellowish cream, very fine-grained, crystalline. Chert 10% (50% 2340 to 2345 feet) subwhite to light gray, conchoidal; some tripolitic	30	2340	2370
97.	Chert 70%, pale, rough to conchoidal, dolomitic. Dolomite 30%, as from 2315 to 2370 feet	15	2370	2385
98.	Chert 40-60%, pale gray, conchoidal to rough, fossiliferous. Shale 25%, gray green, granular, dolomitic. Dolomite 20-40%, light gray, fine-grained, crystalline	50	2385	2435
99.	Chert 50-70%, subwhite, mostly rough, subconchoidal. Dolomite 30-50%, light yellow, fine medium-grained, crystalline	80	2435	2515
100.	Dolomite, light yellowish gray, fine medium- to medium-grained	23	2515	2538
Mohawkin series				
Trenton group				
Galena formation				
Dubuque-Stewartville members				
101.	Dolomite, very light gray, fine medium-grained. Pyrite very abundant at top, decreasing downward	47	2538	2585
Prosser members				
102.	Dolomite 50-70%, grayish yellow, fine medium-grained. Chert, 30-50%, white with brown dolomite phenoclasts.....	60	2585	2645
103.	Dolomite, yellowish buff, fine- to fine medium-grained, crystalline	25	2645	2670
104.	Dolomite 90-75%, as from 2645 to 2670 feet. Chert 10-25%, white, conchoidal, stony and tripolitic	35	2670	2705
105.	Dolomite, gray with dark gray spots, fine-grained, argillaceous, sandy. Pyrite present	10	2705	2715
106.	Dolomite, light buff, fine medium-grained, crystalline	13	2715	2728
Decorah formation				
107.	Shale 50%, bluish green, semifissile, dolomitic; shale 20%, from 2730 to 2735 feet, dark brown, pyritic, phosphatic fragments. Dolomite 50% increasing downward, light gray to cream	22	2728	2750
Black River group				
Platteville formation				
108.	Dolomite, buff, gray spots, fine- to medium-grained, fossiliferous	25	2750	2775

1946]

WELL NEAR OAKLAND, IOWA

245

	<i>Description of Formation</i>	<i>Thickness</i>	<i>Depth in Feet</i>	
			<i>From</i>	<i>To</i>
109.	Limestone, very light brown, fine-grained, black fossil fragments	14	2775	2789
110.	Shale (Glenwood member), green, splintery, black phosphatic fragments, slightly sandy. Dolomite from 2815 to 2823 feet and 30% from 2805 to 2810 feet, buffish brown, fine-grained, crystalline	34	2789	2823
Chazyan series				
St. Peter formation				
111.	Sandstone, white, medium-grained, finely frosted, curvilinear to sub-round	32	2823	2855
Beekmantownian series				
Prairie du Chien formation				
Willow River member				
112.	Dolomite, buff to light gray, fine medium-grained, very sandy. Chert 0-10%, white, stony, conchoidal, oolitic. Sand 10-30%, mostly fine-grained, angular to curvilinear, mostly secondarily enlarged	60	2855	2915
113.	Dolomite 40-70%, cream to light buff, very fine-grained, dense, sandy. Sandstone (Root Valley) 60-30%. white, fine-grained, mostly secondarily enlarged	30	2915	2945
114.	Dolomite 90%, light gray to cream gray, fine medium-grained, crystalline. Sand 10%, loose, as from 2915 to 2945 feet, but medium-grained	30	2945	2975
115.	Dolomite, light yellowish drab, fine-to fine medium-grained. Chert, very light gray, semitranslucent, conchoidal 50% from 2995 to 3000 and 3005 to 3010 feet and less than 10%, intermittently. Sand, loose, fine-grained, angular to curvilinear in lower 30 feet	140	2975	3115
Cambrian system				
St. Croixan series				
Trempealeau formation				
Jordan member				
116.	Sandstone 90%, white, fine- to medium-grained, frosted, slightly secondarily enlarged curvilinear to subangular, dolomitic cement. Dolomite 10%, grayish drab, fine-grained	36	3115	3151

	<i>Description of Formation</i>	<i>Depth in Feet</i>	
		<i>Thickness From</i>	<i>To</i>
	St. Lawrence member		
117.	Dolomite, yellowish drab, fine- to fine medium-grained, crystalline.....	32	3151 3183
		Total depth	3183 feet

IOWA GEOLOGICAL SURVEY,
Iowa City, Iowa.